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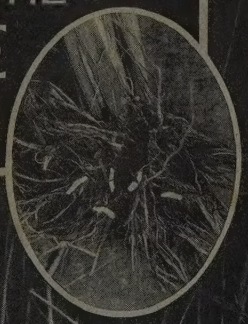
INSECTS INJURIOUS TO THE RICE CROP



A STINKBUG, a water weevil, two species of borers, and several minor pests which attack growing rice lower the yield materially or injure the quality of the grain. These insects are described in the following pages, and the most approved methods of controlling them are set forth.

This bulletin supersedes Farmers' Bulletin 1086, How Insects Affect the Rice Crop.

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INSECTS INJURIOUS TO THE RICE CROP

By J. W. Ingram

Assistant Entomologist, Division of Cereal and Forage Insects, Bureau of Entomology[1]

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THE RICE INDUSTRY in the United States is very fortunate in that the growing crop, unlike most other staple crops, has no insect enemy of major importance. This fact is probably due to the unusual system of agriculture employed in producing it, which provides for continuous submergence of the rice field from about two weeks after the plants have emerged from the soil until the rice is ready to be harvested. There are, however, a number of insect pests that lower the yield materially, or injure the quality of the grain produced, making the adoption of control measures a profitable practice for the rice grower. The injurious insects and their control are discussed in this bulletin.

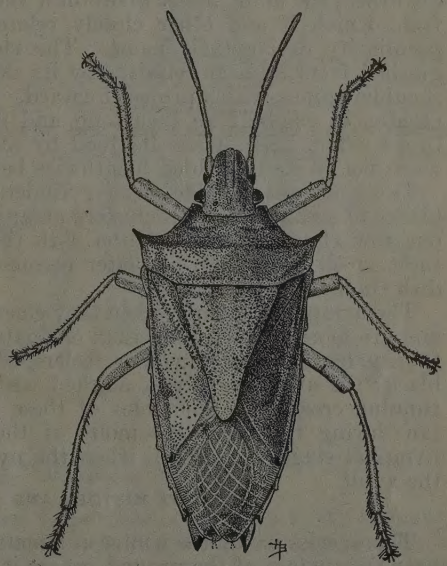

Fig. 1.—The rice stinkbug: Adult. Enlarged 5 diameters. (Webb)

THE RICE STINKBUG

Practically all rice fields in Louisiana, Texas, and Arkansas suffer losses yearly from the attack of the rice stinkbug. (Fig. 1.)[2] This straw-colored, shield-shaped bug sucks the juice from the rice grain by means of its long beak. The

[1] Acknowledgment is made to the Rice Experiment Station at Crowley, La., for laboratory space and the use of experimental plats, and to C. E. Chambliss and J. Mitchell Jenkins, of the Bureau of Plant Industry, for cooperation in the work at Crowley. Acknowledgment is also made to T. E. Holloway, of the Bureau of Entomology, for suggestions in conducting the work reported in this bulletin.

[2] *Solubea pugnax* Fab.

entire contents of the rice grain, when it is in the milk stage, are often sucked out, and a false grain results. Later, as the rice grain reaches the dough stage, the bug extracts a portion of its contents, leaving a chalky, discolored area. Rice so affected is called "pecky rice." A fungus often enters the puncture made by the stinkbug and causes a black speck on the rice grain. Such injured grains are often broken in the process of milling.

The stinkbug thrives best in warm, wet weather. The extent of injury resulting from its attacks varies from year to year with weather conditions during the growing season of the rice crop. The extent of the injury is also influenced by the scarcity or abundance of natural enemies of the pest and by the number of bugs that successfully pass the winter. Injury to rice by this bug varies from a negligible amount to an estimated damage of more than 25 per cent of the grain in the field. Rice fields in and around which there is much grass invariably suffer the heaviest loss from stinkbugs.

DESCRIPTION

The rice stinkbug is a straw-colored, shield-shaped bug. When disturbed, the adult insect gives off a very strong, disagreeable odor, from which it and other closely related species having the same peculiarity derive their name. The rice stinkbug may be distinguished from its near relatives by its elongated shape and its sharp shoulder spines, which project forward. The adult bug is from three-eighths to one-half an inch long and is slightly less than half as broad. The insect takes its food by means of a long beak which, when not in use, is folded lengthwise beneath the body.

The eggs, shaped like short cylinders (fig. 2, A), are found on blades of grass or rice, in clusters arranged in two rows, the eggs of one row alternating in position with those of the other. They are light green when laid, but later become darker and develop a reddish tinge before hatching.

The nymphs, or young, when they emerge from the eggs, are active, and are more nearly round than elongated. (Fig. 2, B.) The head, thorax, legs, and antennae, or feelers, of the newly hatched bug are black; the abdomen is red, marked with two elongated black spots running crosswise. The color of these markings fades into a light tan during the successive molts of the young bug until the last nymphal stage (fig. 2, C), when the nymph more nearly resembles the adult.

LIFE HISTORY AND HABITS

This species passes the winter as a mature bug in heavy, reedy grass near the surface of the ground, where it is protected not only by the grass itself but by accumulations of fuzz from the grass, dust, and other trash. As many as seven overwintering bugs have been found in a single clump of bull grass.[3] The bugs come out of their winter quarters late in April or early in May, according to weather conditions, and begin feeding on a large variety of grasses, preferably those that are making seed at the time. They begin breeding on the grass, and two or three generations are produced there. Then, when

[3] *Panicum agrostidiforme* Lam.

the rice begins to head, large numbers of adult bugs forsake the grass and enter the rice fields, where they begin extracting the juice from the developing rice kernels. Some of the bugs continue to feed on grass throughout the season. There may be as many as four or five generations annually on grass, and two or three on rice.

The eggs are laid in two rows, principally on the upper surface of the leaves of rice or grass, though they are sometimes found on the underside of the leaves, on the stems, and on the heads of the plants. The number of eggs in a single cluster has been known to range

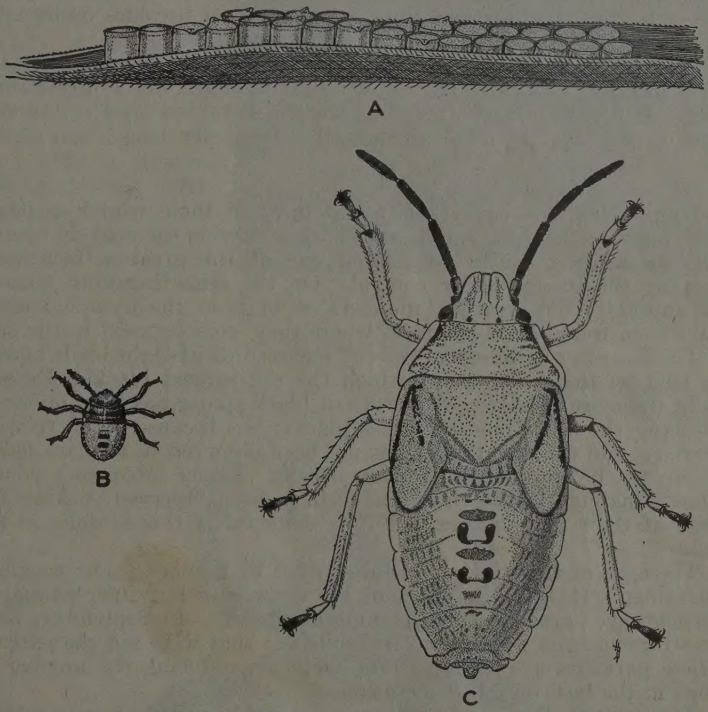

FIG. 2.—The rice stinkbug: A, eggs; B, first nymphal stage; C, fifth (and last) nymphal stage. All enlarged 8 diameters

from 10 to 47. An individual female has been found to lay as many as 150 eggs in her life. One female deposited 138 eggs during a 10-day period. The length of the egg stage varies from 3 days in hot weather to 11 days in the cool weather of spring. Usually the eggs hatch at the end of 4 or 5 days.

The newly emerged bugs remain together near the eggshells during their first period of growth. Directly after their first shedding of skin, however, which usually takes place two days after hatching, each young bug seeks a separate feeding place, generally on the rice head, where it begins sucking the juices from the developing kernels.

The bugs move from place to place on the plant, growing and changing in shape and coloration so as to resemble more and more the adult bugs. The young bugs molt five times in from 15 to 28 days, and then become adults. The total time elapsing between the egg and the adult ranges from 18 to 32 days, or even longer in the cool weather of spring.

About four days after becoming adult, the females begin laying eggs. In hot, sunny weather the adult bugs seek the shade on the underside of leaves and in other convenient places during the day, and come out at night to feed. The bugs can seldom be found in grass during such weather, since, when the heat becomes oppressive, they seek the cool shade near the surface of the ground.

In summer the length of life of the adult varies from a few days to as much as 47 days. The adult rice stinkbug is not a very strong flier. It flies only a short distance when disturbed, and in the rice field it is seldom found in numbers far from dry land.

CONTROL

Many stinkbugs have been found dead in their winter quarters and, judging from the small number that survive the cold of winter, this mortality must be considered one of the greatest factors in keeping the insects under control. On the other hand, in periods of unusually hot weather, numbers of bugs in the nymphal stage have been found dead in places where they were exposed to the sun.

The Bureau of Biological Survey has records of eight birds known to feed on the stinkbug, of which the red-winged blackbird seems to be the most effective. A species of black spider has been observed catching the adult bugs on grass plants; but because of its relative scarcity, and the fact that it has not been observed in the rice fields, it can not be considered of much benefit. Under laboratory conditions stinkbugs in the third instar have been observed sucking the eggs of their own species, but it is doubtful if this is done in the field.

The eggs of the stinkbug are destroyed by two species of wasplike parasites.[4] In the latter part of the summer a large percentage of the eggs are parasitized by these minute insects. In September, 1925, no stinkbug eggs were found in Louisiana that were not parasitized. These parasites are an important factor in reducing the number of bugs in the last, or fall, generation.

The natural enemies of this insect can not be relied upon to control it, however, so that to reduce losses from the stinkbug artificial control is necessary. Since grasses in and around the fields attract the insects and serve them as breeding places, it is a good practice to keep down all grasses on the levees and in and around the fields. Burning or plowing under the grass in the fall or winter serves to destroy the hibernating bugs.

THE RICE WATER WEEVIL

In practically all rice fields in the South the roots of the rice plant are to some extent attacked by the so-called "root maggot," which is the young of a grayish-brown weevil called the rice water weevil.[5]

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[4] *Ooencyrtus anasae* Ashm. and *Telenomus podisi* Ashm.
[5] *Lissorhoptrus simplex* Say.

The results of the feeding of the "root maggot" are most noticeable near the base of the plant, where many of the roots are pruned off. (Fig. 3.) The adult insect, which is a snout beetle, or weevil, feeds on the leaves, and slitlike feeding scars remain as evidence of its work. In some fields of late rice the weevils have been so numerous, and their feedings so heavy, that some plants have been killed as a result of the riddling of the leaves.

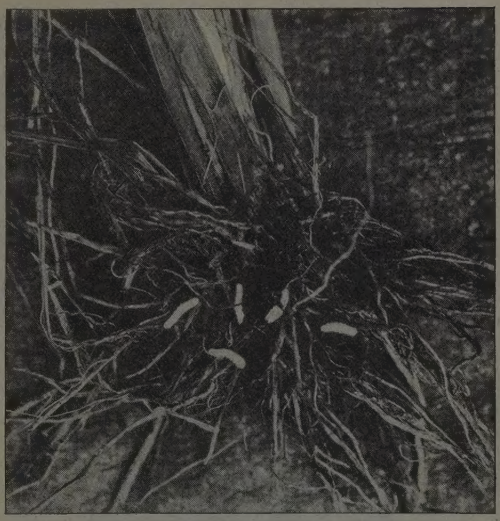

FIG. 3.—Rice "root maggots" among the roots of rice plant. (Webb)

DESCRIPTION

Unlike the rice stinkbug, the water weevil emerges from the egg as a mere footless grub, which changes greatly before becoming

FIG. 4.—The adult rice water weevil. Enlarged 23 diameters. (Webb)

adult. In its life history it goes through four distinct stages, the egg, the larva or grub, the pupa or resting stage, and the adult. The rice water weevil (fig. 4) is normally grayish brown, a darker shade marking the center of its back. When moist, the weevil takes on a greenish tinge. A weevil newly transformed from the pupa varies from very light gray to dark gray, or from purplish and bluish black to solid black. Sometimes the color is a very light gray, mottled with black. The head, thorax, and wing covers of these newly emerged weevils have a glossier, brighter finish than have those of the old weevil. The adult water weevil is about one-eighth of an inch long and about half as broad as long.

The egg, which is laid in the roots of the rice plant, is pure white, cylindrical, and about four times as long as broad. It can barely be seen with the naked eye.

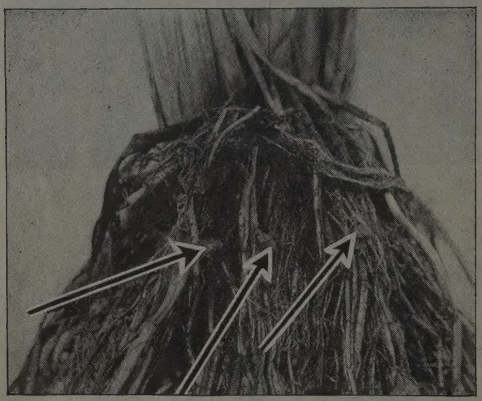

FIG. 5.—Pupal cells of the rice water weevil attached to rice roots. (Webb)

The body of the larva, or "root maggot," is milky white. Its head is very small in proportion to the body and is brown. Upon reaching full growth the larva measures from one-fourth to one-half an inch in length and is very slender. The body is encircled by a number of heavy ridges.

The pupa, or resting stage, is milky white and is invariably inclosed in a cell of mud. This cell is very smooth on the outside and is oval. It is found attached to rice roots. (Fig. 5.)

LIFE HISTORY AND HABITS

The adult rice water weevil lives throughout the winter, its favorite winter quarters being in fine matted grass. In spring, as soon as the rice comes up, the weevils begin to leave their winter shelter and enter the rice fields. They feed at night on the rice leaves, making slitlike longitudinal feeding scars on the upper surface of the leaf, the under side remaining intact. The width of the feeding scar is equal to the width of the mouth parts of the weevil, and its length varies from a small fraction of an inch to more than 2 inches. During the day, when the fields are dry, the weevils hide in the soil at the roots of the rice plants. After the fields are submerged the weevils feed by day as well as by night. When disturbed, they promptly feign death, if they are not in the water. They feed on grass throughout the season, but are most numerous in the spring and the latter part of summer. Weevils have also been found feeding on corn and sugar cane.

When the field is submerged the female weevil begins laying eggs in the roots of the young rice. She chews a small hole in the root, reverses her body, and by means of a pink-colored pipe-shaped ovipositor inserts the egg under the outer covering of the root.

The eggs hatch in about seven days into larvae, grubs, or "root maggots." These larvae at first feed inside the root, hollowing out the interior, but when they become larger they feed on the roots from the outside. The length of the larval stage is from four to five weeks, and possibly longer.

Upon reaching full growth, the larva, or "maggot," forms around itself an oval cell of mud, attached to the roots of the host plant, and it then transforms to the pupa or resting stage. In from about 5 days to 2 weeks an adult weevil emerges from the pupa. The total length of time elapsing between the egg and adult stages ranges from 35 to 48 days. There are as many as two generations of weevils a year. "Root maggots" have been observed in rice as late as September 20. Both larvae and pupae have been found in fields of headed rice. Before the rice begins to head, the majority of the adult weevils leave it and seek fields of younger rice or else fly to grass near by, where they feed on the tender leaves at night and hide during the day. Their feeding on grass diminishes as the season advances. The latest date on which weevils have been observed feeding on grass was September 16, when the longest feeding slit found measured only one-eighth of an inch in length. In July, August, and September the weevils fly at night in search of places in which to feed or hibernate. They are attracted to lights, by means of which they have been captured as far as a mile from the nearest rice field.

CONTROL

So far as is known, the larva and pupa of the water weevil have no natural enemies. A number of snakes and frogs of different species have been dissected and the contents of their digestive tract examined, but no water weevils were found. The contents of the crops of a number of birds have been examined. As many as 81 water weevils have been found in the crop of the red-winged blackbird,[6] but as it feeds on the rice it can not be considered a beneficial bird. The Bureau of Biological Survey has records of nine other birds known to be enemies of this insect. Suspended between grass plants near the rice fields large numbers of spider webs have been found in which were entangled many weevils. As many as seven weevils have been found in a single web.

Drainage of the rice fields for a period of about two weeks, or longer in case of rain, was formerly practiced as a control for the "root maggot." The advisability of this procedure is questionable, since at the time injury by the "root maggot" becomes noticeable the principal damage is practically over. Furthermore, at about the time of this injury the rice plant puts out a new growth of roots, with a resultant shedding of the old ones, which minimizes the damage. The effects of deep water and unfavorable conditions of soil are often mistaken for injury by the "root maggot."

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[6] *Agelaius phoeniceus* (L.).

Many of the overwintering weevils can be destroyed by plowing weeds and grass under in the fall or winter, or by burning these shelters.

BORERS IN RICE

There are two species of borers that feed within the rice stalk; the caterpillars of the sugar-cane moth borer,[7] a major pest of the sugar cane and corn in Louisiana, eastern Texas, and Florida, and the rice stalk borer.[8] These borers have not been found in Arkansas or California, and only the rice stalk borer has been found on rice in Georgia.

The damage caused by these borers is greater than would be suspected from casual observation. Only a small number of rice stalks are killed outright by them. The injury causes the heads of the rice plant to turn white, and from these conspicuous white heads the injury by the borers is generally estimated. But upon examination as high as 32 per cent of the stubble in large fields of rice has been found infested with borers, and it is estimated that a loss of more than one bag of rice per acre has resulted from injury by them. During the growing season the rice stalk is greatly weakened by the tunneling of the borers, and heavy loss from lodging results, especially in windy weather. In late rice many of the young plants are cut so severely just above the water line by the feeding of the numerous little borers that the top of the plant often breaks off. The sapping of the vitality of the plants reduces the yield of the attacked stalks, even of those that mature. The damage from borers is usually heavier in the large-stemmed varieties than in the varieties having a small stem. In areas where both borers attack rice the sugar-cane moth borer is by far the more numerous.

DESCRIPTION

These two species of borers closely resemble one another in all stages of their life history. They pass through four stages in their life cycle: The egg, the larva, or borer, the pupa, and the adult or moth.

The sugar-cane borer moths (fig. 6) are of a straw color, with the forewings showing darker markings. The forewings of the rice stalk borer moth (fig. 7) are lighter in color, having a golden tinge, and are marked with a sprinkling of minute black dots. The hind wings are white. The size of the moth varies with the amount of food taken by the larva, but averages an inch or slightly more from tip to tip of the spread wings.

The eggs of both species are oval and are flattened on the leaf where they are deposited. They are deposited in clusters, overlapping in a cluster in such a way that they form a pattern similar to that of scales on a fish. The eggs are creamy white when laid but develop more of a yellowish color as the incubation period advances. They are laid in groups of from 2 to 100 or more, though the number of eggs usually found in a single cluster is less than 50. It is almost impossible to distinguish the eggs of one species of borer

[7] *Diatraea saccharalis* Fab. [8] *Chilo plejadellus* Zincken.

FIG. 6.—The sugar-cane moth borer: Adult (female). Enlarged 3 diameters. (Holloway and Loftin)

FIG. 7.—The rice stalk borer: *a*, Adult; *b*, larva. Enlarged about 2 diameters. (Webb)

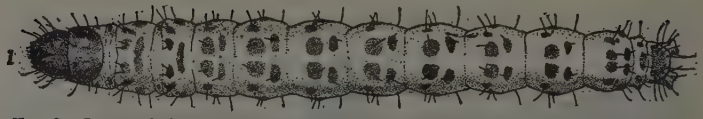

FIG. 8.—Larva of the sugar-cane moth borer. Dorsal view. Enlarged 3 diameters. (Holloway and Loftin)

from those of the other, although it appears that those of the rice stalk borer are more nearly pure white when just deposited.

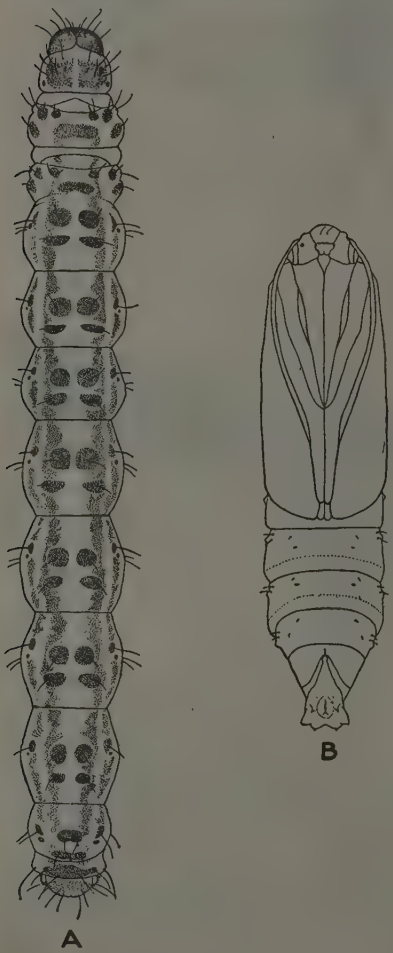

FIG. 9.—The rice stalk borer. A, larva; B, pupa. Enlarged 5 diameters

The larva of the sugar-cane moth borer (fig. 8) is yellowish white with brown spots; in the winter these spots are absent and the color becomes more deeply yellow. The larvæ of the rice stalk borer (fig. 9, A) is yellowish white, and is marked on the sides with two brown stripes running the entire length of its body and two fainter brown stripes below them. These stripes serve to distinguish this larva from that of the sugar-cane moth borer, which has no stripes. These stripes are noticeable in both winter and summer. The larva of each of these borers is about 1 inch long when full-grown.

The pupæ vary in color from light to dark brown. The pupa of the rice stalk borer (fig. 9, B) is smoother, and tapers more evenly to a point at the rear than does that of the sugar-cane moth borer. The pupa of the rice stalk borer is nearly always found inclosed in a heavy web, whereas the pupa of the sugar-cane moth borer (fig. 10) is not so inclosed. The pupæ average about two-thirds of an inch in length by one-sixth of an inch in breadth.

LIFE HISTORY AND HABITS

Both species of borers spend the winter in the larval stage in rice stalks and stubble. The sugar-cane moth borer hiber-

nates also in grass, corn (to a slight extent), sugar cane, and other plants of this family. With a single exception, the rice stalk borer has been found only in rice. Most of the overwintering larvæ of the sugarcane moth borer in rice are found in the crown of the plant, where moisture is available. In most cases where a larva is found above the crown it is surrounded by wet, sawdustlike refuse matter from the borer. The overwintering larvæ of the rice stalk borer are usually found in the joints of the rice stalk, about three joints above the crown, where the plant is dry. They appear to be unable to survive the winter in wet quarters. The larvæ of the rice stalk borer have been found spending the winter in rice straw in the stack. It is most probable that sugarcane moth borers do likewise.

The larvæ transform to pupæ in the spring. The moth of the sugar-cane moth borer begins emergence in May. This species breeds on grasses, corn, and sugar cane until the rice reaches sufficient size to be bored. The moth of the rice stalk borer does not emerge until a later date. Soon after the rice has begun to joint, the moths of both species begin laying eggs on both the upper and lower surfaces of the rice leaves. The egg-laying period of a moth lasts from one to six days. The number of eggs laid by a moth varies from a small number to several hundred, averaging about 200. One female sugarcane borer moth has been known to deposit 203 eggs in a single night. The moths conceal themselves in the daytime and fly by night, so that they are seldom observed in the field.

Minute borers of both species emerge from the eggs in from 4 to 9 days. The eggs hatch when immersed in water as well as when dry, though the incubation lasts about 2 days longer. The young borers hatched in water crawl up the leaf and out of the water. Borers newly hatched on a leaf above water feed there for a short time, then crawl down the leaf to the stem of the plant, and bore their way into the rice stalk. The larvæ, or caterpillars, tunnel up or down the stalk, shedding their skins at intervals and growing until they attain full size. Usually from 24 to 30 days are spent in the caterpillar stage. Upon reaching maturity they transform to pupæ inside the stalk, from which the adult moths emerge in 6 or 7 days. In the case of both species there are two or three generations per year in rice.

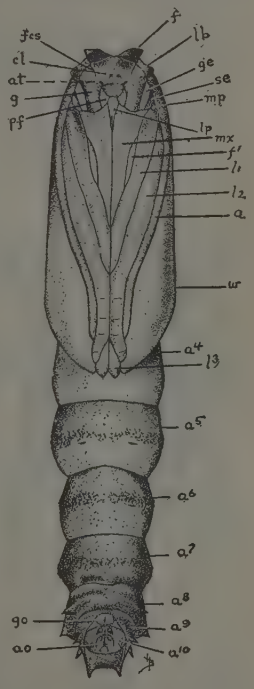

FIG. 10.—Pupa of the sugarcane moth borer. Enlarged 6 diameters. (Holloway and Loftin)

CONTROL

The cold weather of winter kills large numbers of the hibernating larvæ, and is undoubtedly the greatest factor in the natural control of these pests. The eggs of both species of borers are parasitized by

a chalcis fly,[9] but these wasplike insects do not become numerous until late in the season. Another wasplike parasite[10] has been found to destroy the larvæ of both species, but it seems to be present only in small numbers.

Increasing the depth of irrigation water in the fields causes many borers to desert their tunnels, and when they are exposed on the surface of the water they are soon eaten by minnows. On the other hand, borers of both species have been found feeding in rice below the water line.

Since the sugar-cane moth borer is by far the more numerous of the two species attacking rice, it would be well to refrain from growing near the rice fields corn or any related crop which might serve as a host for the borer. In practically all fields of rice grown near corn, the damage by borers, bred in the corn, has been heavier than the average. It would be well, likewise, to keep down heavy grass in the vicinity of the field, especially in the spring, before the rice becomes large enough to serve as a host for the borers. Burning off the grass in winter destroys many of the hibernating borers. Grazing the rice fields in the fall and winter tramples down the stubble, exposing the borers and allowing water to enter their winter quarters, with the result that many borers are killed by cold weather. Plowing the stubble under in the fall or winter also destroys many hibernating larvæ.

FIG. 11.—The sugar-cane beetle. Adult. Enlarged 3 diameters

Precautions should be exercised in shipping rice straw from infested to uninfested localities, since it is evident that borers can be carried by this means.

MINOR INSECT PESTS

A black beetle commonly called the sugar-cane beetle,[11] or rough-headed corn stalk beetle, has been found injuring rice both before the first irrigation and after the water has been drained off previous to harvesting. This insect is a chunky, black beetle, about five-eighths of an inch long and about one-half as broad. (Fig. 11.) It spends the winter as an adult beetle in the soil. The adults emerge in April and May and feed upon sugar cane, corn, rice, and other grasses. They feed upon rice before the irrigation water is applied. The beetle gnaws the stems between the surface of the ground and the roots of the plant, usually causing it to wither and die, although it sometimes sends out a new shoot. When feeding, the beetle often gnaws several plants in succession, which may result in killing many plants in a row. This damage makes its work very noticeable. Rice plants growing on levees may be injured throughout the season by this species.

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[9] *Trichogramma minutum* Riley.
[10] An undescribed species of Microbracon.
[11] *Euetheola rugiceps* Lec.

The beetle lays its eggs in the ground, near to or in contact with the plant on which it has been feeding. The egg is round and glossy white; in a short time it hatches into a white grub, or larva (closely resembling the common white grub) which spends its entire life in the soil, feeding on decaying matter. In July and August the grub transforms to a pupa, or resting stage, from which the adult beetle emerges in a few days. The newly emerged shiny black beetle contrasts strongly in appearance with the dull-black overwintered beetle seen in the spring. These beetles breed mainly in sod lands, especially those that are poorly drained.

When the water is drained from the rice field, before harvesting, the newly emerged beetles fly in and gnaw the rice stalks just above or at the ground line, the place of feeding depending upon the degree of shade afforded by the stalks. As a result, some of the attacked stalks fall over, and many more fall during the first high wind. When the stalks fall over they are not picked up by the binder, and much of the grain sprouts because of its contact with the wet soil. In one large field visited by the writer about 85 per cent of the stalks were found to be gnawed, and a loss of about 15 per cent of the crop had resulted from fallen stalks.

In the spring the beetles may be controlled by submerging the attacked field. They will then either be drowned in the soil or come to the surface of the water. In the latter case some may drift against the levees and escape, but the majority will be drowned. When beetles appear in large numbers soon after the field is drained in preparation for harvesting, the field should be submerged again, and not drained until a few days before harvest time. If beetles are known to be causing injury in surrounding fields, the water should not be drained off until a few days before cutting the rice. Plowing or cultivation of sod lands, their main breeding place, aids materially in reducing the number of beetles.

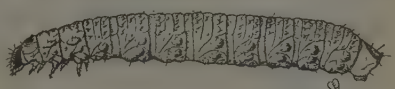

FIG. 12.—The southern corn rootworm. Enlarged about 4½ diameters. (Luginbill)

A small yellow worm called the southern corn rootworm [12] (fig. 12) attacks the sown rice seed and the young seedlings. It may seriously affect the seed, and either kill or injure the young seedling by boring into the stem or cutting it off below the surface of the ground. Rootworms are occasionally present in the rice fields in such large numbers that they seriously reduce the stand, sometimes making reseeding necessary. This worm is the larval form of the 12-spotted cucumber beetle (fig. 13), which lays its eggs near to or in contact with the rice plant. The damage from this insect is usually greater on new land than on land that has been under cultivation for some time.

Since the damage from this insect is greatest in early spring, when the germination and growth of the rice are slow, rootworm injury can apparently be avoided to a large degree by late seeding. Rice sown after April 24 is not often seriously damaged. The worms can be destroyed by submerging the fields when the rice is of sufficient size to permit it.

The grass worm [13] (fig. 14) which feeds ravenously on the leaves and stems of young rice, sometimes causes considerable damage. It

[12] *Diabrotica duodecimpunctata* Oliv. [13] *Laphygma frugiperda* S. & A.

FIG. 13.—The 12-spotted cucumber beetle. Adult, enlarged about 8 diameters. (Luginbill)

is very easily controlled by submerging the infested fields.

The larva of another borer[14] has been found boring in rice. In the middle of its body this borer is of about the same size as the sugar-cane moth borer, but tapers toward each end. Two purplish longitudinal stripes run the entire length of its body. This borer is very rare in comparison with the two borers previously mentioned, and is of little economic importance.

The chinch bug[15] (fig. 15), although present in Louisiana and Texas, seldom if ever causes serious damage to rice. This insect, however, has caused heavy losses to the rice crop of Arkansas. In that State it has been known to enter rice fields in large numbers and to injure seriously the young rice plants before it was time for submergence. Both adult and young bugs, or nymphs, attack rice. When present in large numbers the feeding of the bugs causes the plants to wither and die. In some cases the proportion of plants killed is so large that reseeding is necessary. The insect feeds mainly on the stem, just above the surface of the ground. Where the soil conditions permit they feed below the surface also. Because of these habits they are seldom noticed in the field until the rice begins to die.

Chinch bugs may be controlled by submerging the infested field. The insects spend the winter in dry grass, straw, and other material that affords them shelter. The burning or plowing under of such material in the fall

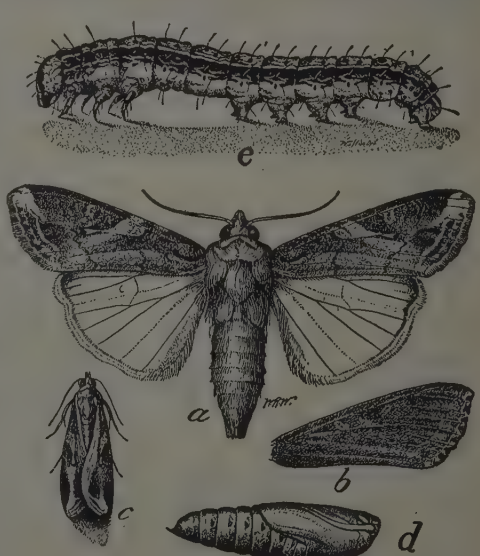

FIG. 14.—Southern grass worm or fall army worm: *a*, Male moth; *b*, right front twig of female moth; *c*, moth in resting position; *d*, pupa; *e*, full-grown larva; *a*, *b*, *d*, *e*, enlarged about 2 diameters; *c*, slightly enlarged. (Walton and Luginbill)

[14] Family Pyralidae, presumably a species of Crambus.

[15] *Blissus leucopterus* Say.

or winter reduces the number of bugs emerging the following spring.

A flea beetle[16] has been observed feeding on the leaves of rice, though the injury has been small.

Among other insects that have been observed attacking rice are a leaf roller, grasshoppers, and a number of sucking insects. The damage caused by them, however, is seldom serious enough to attract much attention.

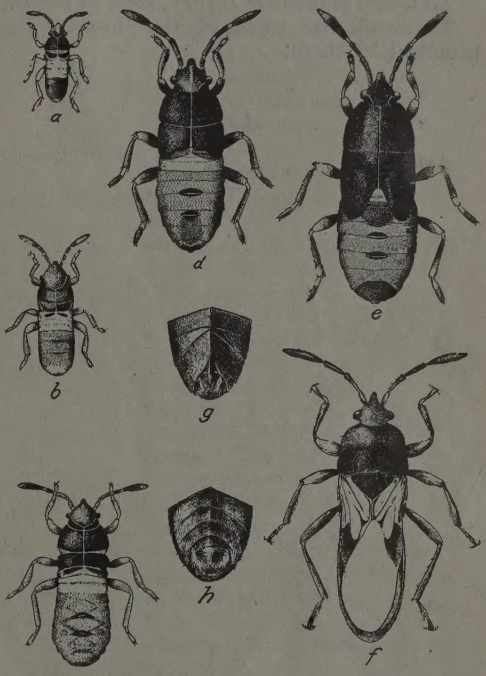

FIG. 15.—Chinch bug. *a* to *d*, First to fourth stages, respectively; *e*, nymph, or pupa; *f*, adult female, long-winged form; *g*, female genitalia; *h*, male genitalia; *a* to *f*, enlarged about 6 diameters; *g* and *h*, more highly enlarged. (Webster)

INSECTS IN CALIFORNIA RICE FIELDS

California rice fields have always been singularly free from insect enemies. None of the insects of major importance that injure rice in Louisiana, Arkansas, and Texas have been found in California fields. Grasshoppers of several species have been found feeding upon the rice leaves and the developing grain. The western 12-spotted cucumber beetle[17] has also been observed in large numbers feeding on leaves and on the grain, but most of the individuals of this species seem to prefer rice pollen to other food. Leaf hoppers, flea beetles, and leaf tyers have also to a small extent been found feeding on rice. None of the pests discovered thus far have been known to cause serious damage to the rice crop. The main problem in California, therefore, is to prevent the injurious rice insects in other parts of the United States and in foreign rice-growing countries from entering the rice fields of that State.

SUMMARY OF CONTROL MEASURES

Eliminate breeding places of stinkbugs and borers by keeping down grass in and around the rice fields.

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[16] *Systena frontalis* Fab.

[17] *Diabrotica soror* Lec.

The winter treatment of rice fields and surrounding areas should include plowing, burning over, or pasturing.

To keep down the number of borers breeding near the fields of rice, refrain from growing corn or related crops near them.

Submerge the fields if possible when young rice is attacked by rootworms, chinch bugs, or sugar-cane beetles.

To lessen rootworm injury, seed in the last week of April, or later.

To check the work of rice insects, rotate rice with crops not attacked by them.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

November 23, 1927

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